Maturing the PSP: Developing a Body of Knowledge and Professional Certification for PSP-Trained Software Developers

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In the decade since its introduction, the Personal Software Process^{SM} *(PSP*^{SM}*) methodology has been adopted by thousands of individuals and dozens of major corporations the world over. As adoption of the PSP continues to grow, it has become critical to delineate and document the core skills and knowledge that set PSP practitioners apart from other software engineers. The PSP Body of Knowledge Vers. 1.0 was released by the Software Engineering Institute in September 2005 to serve this purpose and to provide individuals, organizations, and academic institutions with an objectively defined set of guidelines against which they can measure individual capabilities of engineers as well as assess or develop content for PSP-related training courses, curricula, or credential programs.*

In his book "Software Craftsmanship: The New Imperative" [1], Pete McBreen makes the case that the software engineering profession is based on the wrong metaphor: Instead of an industrial model that views programmers as interchangeable parts in an assembly line development strategy that uses a one-size-fits-all process, software development should be classified as a form of craftsmanship. McBreen says that better software projects and higher-quality products will result only when software development shifts from applications of industrial solutions to software problems – for example, shifting from throwing volumes of personnel at troubled projects in an effort to get the work done faster – to focusing attention on practices typically associated with fine crafting. This includes rewarding developers for the disciplined implementation and mastery of their profession; allowing professionals to use situationally appropriate, flexible processes; encouraging people to work together as members of small, collaborative teams; and encouraging people to stop mass-producing good-enough software and to start creating high-quality work to which they would be proud to sign their names.

These tenets are consistent with the philosophy underlying the Software Engineering Institute's (SEI^{SM}) Personal Software Process^{SM} (PSP^{SM}), a proven effective method that takes just such a craftsman-like approach to software engineering. PSP-trained developers strive for quality at the individual level, take pride in and responsibility for the work that they produce, and use defined and disciplined tailorable processes to produce high-quality work on planned schedules for predictable costs. The

PSP also provides flexibility since it is language-independent, allows for tailoring to mesh with established organizational processes, and can be implemented at any (or every) phase of the software development life cycle. It can also be tailored to fit various project needs and scaled up or down to address the needs of teams ranging in size from three or four individuals to larger teams of teams.

> ***"… a body of knowledge is defined as a document generated by masters of a particular profession to identify and delineate the concepts, facts, and essential skills that professionals and practitioners in that profession are expected to have mastered."***

Since the introduction of the PSP methodology to the developer community in 1993, its effective use in a variety of academic and industrial settings has been documented in numerous peer-reviewed journal articles and technical reports [2, 3]. This has led to exponential growth in the adoption of PSP during the last decade (along with growing adoption of its sister technology, the

Team Software Process^{SM} [TSP^{SM}]) by many leading organizations in the software development community.

The PSP Body of Knowledge

During the past decade, a variety of articles, books, and conference proceedings have documented the successful implementation of PSP methodologies in a variety of settings. The PSP technology has now reached a level of maturity sufficient to allow – even require – further refinements to be made by the community of PSP users, academic institutions, and certification entities. To encourage and facilitate this effort, the SEI's Software Engineering Process Management program authorized the creation of a PSP Body of Knowledge (PSP BOK).

For the purposes of this article, a *body of knowledge* is defined as a document generated by masters of a particular profession to identify and delineate the concepts, facts, and essential skills that professionals and practitioners in that profession are expected to have mastered. The PSP BOK is derived from published literature and documented reports of practitioner experience. It is meant to be a concise, one-stop reference source that provides an overview of the knowledge and skill areas that are considered by expert PSP users to reflect the best practices and essential core abilities required for successful implementation of the PSP methodology. The PSP BOK is not meant to be an exhaustive list of every supporting detail, fact, or formula used in the PSP, nor should it be regarded as a *Cliffs Notes*-type replacement for the original source documents describing the PSP methodology [4, 5, 6]. The main purposes of the PSP BOK are the
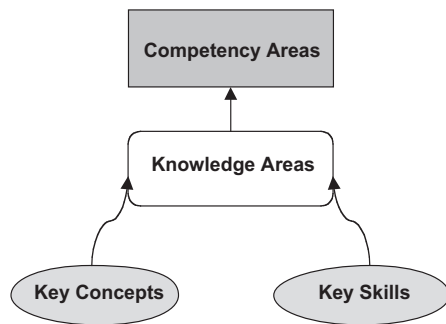
Figure 1: *BOK Architectural Hierarchy*

following:
- Define and characterize the basic essential competencies and standard practices that a PSP-trained professional is expected to master.
- Provide a consistent view of PSP in the community.
- Delineate the skills and knowledge that set PSP-trained professionals apart from other software developers.
- Encourage and facilitate the establishment of PSP-based courses and/or software engineering programs in academic institutions at both the undergraduate and gradu-

ate levels.
- Establish an objective baseline for developing and/or assessing PSP courses and curricula.
- Provide an established baseline for PSP certification or credential programs.
- Enable employers to objectively assess the software skills and capabilities of their software developers and project development teams.

The PSP BOK is organized according to an architectural hierarchy, in which related key concepts and skills are grouped into knowledge areas that, in turn, are grouped into competency areas (see Figure 1). The PSP BOK uses the term *key concept* to describe the intellectual aspects of the PSP content; that is, the essential information, facts, terminology, and philosophical components of a technology. The term *key skill* refers to the ability of an engineer to apply knowledge to perform a task. Together, a group of related key concepts and key skills form a *knowledge area* and, in turn, groups of related knowledge areas constitute a *competency area*.

Version 1.0 of the PSP BOK is composed of seven competency areas:

1. Foundational knowledge from other disciplines (e.g., statistics).
2. Basic concepts of the PSP.
3. Size measuring and estimating.
4. Making and tracking project plans.
5. Planning and tracking software quality.
6. Software design.
7. PSP process extensions.

Each competency area is composed of between three and seven knowledge areas which, in turn, contain one or more component key concepts, key skills, or a combination of the two, along with a brief description of the relevance and/or application of the concept or skill. The PSP BOK extracts in Tables 1, 2, and 3 provide an example of the structure and content of the BOK. The complete document can be downloaded from the SEI's publications Web site, <www.sei.cmu.edu/publications/documents/05.reports/05sr003.html>.

As PSP use continues to grow, further additions and evolutions to the BOK will inevitably follow, particularly in the competency area covering process extensions. The PSP BOK authors invite knowledgeable PSP users to submit suggestions and input for future revisions to the BOK.

Applications of the PSP BOK

The PSP BOK is intended for use in a variety of professional, industrial, and academic settings. For example, it can be used as a basis for credentialing practitioners who have attained proficiency in all of the key concepts and skills that the BOK comprises. This section discusses several potential uses of the PSP BOK in more detail.

Information contained in the PSP BOK can be used by individuals and employers in assessing the skills of software development professionals. Since personnel costs constitute well over half the budget of most software development projects, the skills of software developers have a large effect on the cost, schedule, and quality of the products produced. Employers are increasingly interested in hiring individuals who possess skills that allow them to work in a variety of software domains using disciplined and replicable methods – such as PSP – to consistently turn out well-crafted and high-quality work.

The essential concepts and skills required for proficient implementation of the PSP methodology are delineated in the PSP BOK. Therefore, the docu-

Table 1: *Example of BOK Competency Area Content and Organization*

Competency Area Number and Name	7. Process Extensions and Customization
Competency Area Description	This competency area describes the modifications to the PSP that are required when scaling up from smaller programs to larger ones, when working with unfamiliar situations or environments, or when moving to team-based development instead of working alone.
Knowledge Areas	7.1 Defining a Customized Personal Process 7.2 Process Evolution 7.2 Advanced Process Applications
References	[Horn 90] [Humphrey 95, pp. 483-485, 725-740] [Humphrey 05a, Chapter 13]

Competency Area 7: Process Extensions and Customization

Table 2: *Example of BOK Knowledge Area Content and Organization*

Knowledge Area Number and Name	Description
7.1 Defining a Customized Personal Process	A defined process should not be regarded as *one size fits all*. This knowledge area addresses situations in which processes must be customized to meet changes in needed outputs or developed from the ground up to address new situations or environments.
7.2 Process Evolution	A process cannot be evolved to fit changing needs or situations until the current process accurately represents what is actually done when using that process. This knowledge area addresses the activities involved with incrementally evolving an initial process into one that is an accurate and complete description of the actual process.
7.3 Advanced Process Applications	Experienced PSP users may encounter situations when the original PSP processes may not be conveniently applicable for planning and developing a product. Modifications of the PSP, such as the Prototype Experimental Process (PEP) and the Product Maintenance Process (PMP), allow the application of PSP concepts and skills to such situations.

Description of the Process Extensions and Customization Knowledge Areas

ment can be used to assist software engineering professionals in assessing their own skills and proficiencies and in identifying areas in which they may need further improvement. The PSP BOK can also be used by employers who want to establish an objective baseline for measuring the software development skills and capabilities of their engineers and product development teams. By understanding software engineering best practices, the industry can implement improvement efforts within its organizations, thereby achieving higher quality products and better management of costs and schedules.

The PSP BOK can assist academic institutions in updating software engineering or computer science curricula to reflect current software development practices used in industry. With the growing adoption of PSP and TSP, it is likely that employers will begin to require that newly hired developers possess PSP skills. The PSP BOK provides academic institutions with guidelines that will help them prepare students to work in industries that require individuals who are able to follow disciplined software development practices. Some institutions may choose to offer a PSP course, while others may choose to integrate PSP into several of their courses.

In both cases, institutions can use the guidance provided by the PSP BOK to ensure that students receive adequate instruction in and experience with fundamental PSP concepts and practices. PSP instruction offered by academic institutions will also provide a benchmark for industrial or commercial entities that may be interested in developing training programs based on the PSP BOK. Academic instruction in the BOK competencies, knowledge areas, key concepts, and key skill areas also provides a baseline for assessing the quality of instruction offered through industrial or commercial training or other such venues.

The PSP BOK may also serve as a foundation for creation of credentials or certifications that serve as a hallmark of a professional's ability to craft high-quality products. Certification is one of the most widely used mechanisms employed by a profession to make explicit the core set of knowledge and skills that a professional is expected to master. Certification also establishes a mechanism for objectively assessing mastery of those core competencies, and provides a foundation for continuing qualification of individual profes-

Key Concept Number and Name	Description
7.3.1 Prototype Experimental Process (PEP)	Use the PEP when working in unfamiliar programming environments or when building prototype systems with loosely defined or poorly understood requirements.
7.3.2 Product Maintenance Process (PMP)	Use the PMP when making modifications, enhancements, or repairs to legacy systems with large or defective base code.

Knowledge Area 7.3: Advanced Process Applications
Experienced PSP users may encounter situations when the original PSP processes may not be conveniently applicable for planning and developing a product. Modifications of the PSP such as the Prototype Experimental Process (PEP) and the Product Maintenance Process (PMP) allow the application of PSP concepts and skills to such situations.

Table 3: *Example of BOK Key Concepts Content and Organization*

sionals.

Thus, the PSP BOK provides an objective and concise description of the necessary skills and knowledge needed for attaining a *craftsman* level of competence in software development. The successful completion of courses, curricula, or credential programs that are based on the content of the PSP BOK provides a tangible measure of an individual's proficiency as part of an elite guild of software development crafters.

Conclusion

As PSP has gained acceptance by a broad spectrum of users within the software engineering community, the methodology has achieved sufficient stability and maturity to necessitate the documentation of the core skills and knowledge that set PSP practitioners apart from other software engineers. The PSP BOK Vers. 1.0 was released by the SEI in September 2005 to serve this purpose and to provide individuals, organizations, and academic institutions with an objectively defined set of guidelines against which they can measure individual capabilities of engineers, as well as determining the content required for effective PSP-related training courses or curricula. Completion of courses, curricula, or credential programs based on the PSP BOK will allow software professionals to effectively demonstrate the specialized knowledge and skills that set them apart from other programmers and allow them to consistently produce high-quality, well-crafted products.◆

References
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